Journey to the center of the Earth -- Scientists explain tectonic plate motions

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The first direct evidence of how and when tectonic plates move into the deepest reaches of the Earth is published in *Nature* today. Scientists hope their description of how plates collide with one sliding below the other into the rocky mantle could potentially improve their ability to assess earthquake risks.

The UK and Swiss team found that, contrary to common scientific predictions, dense plates tend to be held in the upper mantle, while younger and lighter plates sink more readily into the lower mantle.

The mantle is a zone underneath the Earth's crust encompassing its super hot molten core. It is divided into an upper and lower area, and is made

up of a 2,900 km circumference of churning, viscous rock. It is constantly fed with new material from parts of tectonic plates which slide down from the surface into it.

The researchers' numerical models show how old, dense and relatively stiff plates tend to flatten upon reaching the upper-lower mantle boundary, 'draping' on top of it. Their models are helping to explain plate movements and earthquakes in the Western Pacific, where old plates currently sink below Tonga, the Mariana Islands and Japan.

By contrast, younger more malleable plates tend to bend and fold above the boundary of the lower mantle for tens of millions of years until they form a critical mass that can sink rapidly into the lower mantle.

When this mass moves into the lower mantle, the part of the plate still at the surface is pulled along at high speed. This explains why plate movements below Central and northern South America are much higher than expected for such young plates.

The scientists came to these conclusions by using a numerical model, originally used to show how buildings buckle and fold, which calculates the brittleness, stiffness and elasticity of tectonic plates alongside how the pressures and stresses inside the mantle would affect the plate on its downward descent.

They then compared the modelling with plate movement data. By comparing the two models, the team was able to build up a clear picture of how plates should move when stalled in the upper mantle and also show, for the first time, how tectonic plate rock is mixing within the mantle.

Commenting about the study, lead researcher Dr Saskia Goes, from Imperial College London's Department of Earth Science and

Engineering, said:

"It is exciting to see direct evidence of plates transiting from the upper and lower mantle. This process has been predicted by models before, but no one has been able to link these predictions with observations, as we now do for plate motions."

When two tectonic plates collide, with one sliding below the other and sinking into mantle, it can lead to the formation of mountain belts, like the Andes, and island arcs, like Japan and, in some places, cause explosive volcanism and earthquakes. Dr Goes say more research is needed, but believes this study could potentially help scientists determine earthquake risks in parts of these zones where none have ever been recorded before.

"The speed with which the two plates converge, and the force with which they are pushed together, determine the size of the largest earthquakes and time between large tremors. Understanding what forces control the plate motions will ultimately help us determine the chances for large earthquakes in areas where plates converge, in places like the northern U.S., Java and northern Peru, but where no large earthquakes have been recorded in historic times," she adds.

Source: Imperial College London

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